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Research Article

EXPLOITATION OF GENETIC VARIABILITY AND TRAIT ASSOCIATION ANALYSIS FOR VARIOUS QUANTITATIVE TRAITS IN ADVANCE BREEDING LINES OF DESI CHICKPEA (*CICER ARIETINUM* L.)

SOLANKI R.S.*, KUMAWAT S., BISWAL M. AND BABBAR A.
[1]Department of Plant Breeding & Genetics, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Adhartal, Jabalpur, 482004, Madhya Pradesh, India
*Corresponding Author: Email - ravindrasolankijnkvv@gmail.com

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Abstract: This study was conducted on 45 advance breeding lines of desi chickpea (*Cicer arietinum* L.) to determine heritability, variability and association analysis for yield and its related traits. Genotypic and phenotypic coefficient of variation found high for seed yield per plant, number of effective pods per plant, number of effective pods per plant, biological yield, number of primary branches and number of secondary branches. High heritability coupled with high genetic advance as percent of mean was registered for seed yield per plant followed by biological yield, number of effective pods per plant and total number of pods per plant. The trait association analysis revealed seed yield per plant showed positive and significant correlation with biological yield, number of effective pods per plant, total number of pods per plant and days to maturity, while significant negative correlation with days to flower initiation days to 50% flowering and pod initiation. Number of effective pods per plant, total number of pods per plant, biological yield and harvest index exhibited high direct positive effect on seed yield per plant. Research findings suggested genotypes having high biological yield with more secondary branches, total number of pods per plant and number of effective pods per plant should be considered selection criteria for improving seed yield in chickpea.

Keywords: Chickpea, Correlation, Path analysis, Heritability, Genetic advance, Seed yield

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Introduction

Chickpea (*Cicer arietinum* L.) is the second most important pulse crop in the world after dry bean an important source of human food and animal feed; improve soil fertility, particularly in dry lands. To meet out the ever-increasing demand for chickpea, there is a need to break the yield barriers by developing high yield and biotic/abiotic resistant varieties. Yield is a complex character which is influenced by many dependent characters. The dependent characters which are associated with yield component traits are themselves interrelated. Selection based on yield may not be rewarding, therefore improvement in yield is possible through selecting yield component traits which show close association with yield. Hence further scrutiny is necessary by using path coefficient analysis which is a statistical technique of decomposing the correlation coefficient into direct and indirect effects. Hence, the present study was carried out to assess genetic variability and the factors determining the seed yield in chickpea through correlation coefficient and path analysis [1-5].

Materials and Methods

The present investigation was carried out at Seed Breeding Farm, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur during rabi-2017-18. The experimental materials consisted 45 advanced breeding lines of desi chickpea laid out in Randomized Complete Block Design with three replications. All recommended package of practices was followed during the cropping period to raise a good crop. Observations were recorded for fourteen quantitative characters *viz*., days to flower initiation, days to 50% flowering, days to pod initiation, days to maturity, plant height (cm), number of primary branches, number of secondary branches, total number of pods per plant, number of effective pods per plant, number of seeds per pod, 100 seed weight (g), biological yield (g), harvest index (%) and seed yield per plant (g). The data was subjected to the standard statistical analysis for genetic parameters, correlation coefficient and path analysis.

Results and Discussion

The analysis of variance depicted significant difference between the genotypes for fourteen quantitative traits indicated presence of sufficient amount of variability for all the traits. Results showed that, high range observed for seed yield per plant, total number of pods per plant, number of effective pods per plant, indicating the scope for selection of initial breeding material for further improvement based on these traits. Keeping in view, under this investigation the genetic variability assessment was carried out. Extent of genetic variability among crop plants is key to the success of any breeding programme. The extent and less differences between phenotypic and genotypic coefficient of variation was recorded for phenological traits *viz*., days to flower initiation, days to 50 % flowering, days to pod initiation, days to maturity concluded that there was low variability and less influence of environment on the expression of these traits [Table-1]. The PCV % was higher than the GCV% for plant height, number of primary branches, number of secondary branches and number of seeds per pod indicates influence of environment on the expression of these traits. Similar results found by [2, 9, 14, 15-19]. High GCV% and PCV% were recorded for seed yield per plant (49.3% and 50.4%) followed by number of effective pod per plant (46.7% and 48.8%) and total number of pods per plant (45.1% and 47.5%) biological yield (43.9% and 44.9%), number of primary branches (29.3% and 36.9%) and number of secondary branches (32.0% and 40.2%). Traits having high genotypic coefficient variation indicates high potential for effective selection for further improvement programme. Information about extent of parental traits contribution towards progeny is the major success indicator; helps in formulation of breeding strategies because higher heritability of a trait simplifies the selection procedure. The magnitude of heritability ranged from 52.0% for number of seeds per pod to 97.5% for days to maturity [Table-2].The estimates of high heritability was recorded for days to maturity (97.5 %) followed by seed yield per plant (95.8 %), biological yield per plant (95.7%), number of effective pods per plant (91.6%) and

Table-1 *Estimates the genetic parameters for quantitative characters in chickpea genotypes*

Characters	Grand mean	Range		Coefficient of Variation		h^2% (bs)	GA as % of mean at 5%
		Min	Max	GCV (%)	PCV (%)		
DFI	51.7	43	57.3	4.9	5.3	83.8	9.2
DF 50%	57.9	47.6	62	5.2	5.5	88.8	10.2
DPI	66.9	53	74	6.6	7	90.8	13.1
DM	102.7	91.3	118.3	6.4	6.5	97.5	13
PH	46.2	40	59.9	13.2	15.8	58.3	18.5
PB	1.8	1.2	4.2	29.3	36.9	63.1	48.1
SB	3.6	1.4	7.1	32	40.2	63.4	52.4
TNP	51.1	29.3	127.3	45.1	29.3	90.2	58.2
NEP	49.5	27	126.7	46.7	48.8	91.6	59.1
NSP	1.5	1.3	1.8	8.5	13.1	52	11.4
100SW	21.2	14.3	32.1	17.6	19.4	82.3	33
BY	26.3	11.6	62	43.9	44.9	95.7	58.5
HI	55.2	40	73.3	14.4	16.5	76.1	25.8
SYP	14.2	6.4	40.8	49.3	50.4	95.8	47.4

*Significant at 5% level, **Significant at 1% level. Abbreviation: DFI: Days to flower initiation, DF50%: Days to 50% flowering, DPI: Days to pod initiation, DM: Days to maturity, PH: Plant height, PB: Number of primary branches per plant, SB: Number of secondary branches per plant, TNP: Total number of pods per plant, NEP: Number of effective pods per plant, NSP: Number of seeds per pod, 100 SW : 100 seed weight, BY: Biological yield, HI: Harvest index, SYP: Seed yield per plant

Table-2 *Phenotypic correlation coefficient analysis for yield and its related traits in chickpea*

Ch.	DFI	DF 50%	DPI	DM	PH	PB	SB	TNP	NEP	NSP	100SW	BY	HI	SYP
DFI	1	0.7975**	0.7342**	0.13	0.0132	0.2407**	0.0971	-0.1486	-0.1465	0.1183	-0.0245	-0.1612	-0.1017	-0.1819*
DF 50%		1	0.7647**	0.0447	0.1414	0.1096	0.0995	-0.2715**	-0.2728**	0.0269	0.119	-0.1654	-0.1749 *	-0.2284**
DPI			1	0.0096	0.1397	0.2714**	0.2550**	-0.2465**	-0.2479**	-0.0707	0.0956	-0.1578	-0.121	-0.2019*
DM				1	0.0596	0.1455	0.1114	0.4543**	0.4607**	0.0415	-0.0167	0.5680**	0.1689	0.5995**
PH					1	0.0427	0.3240**	0.1614	0.1375	-0.0807	0.048	0.1735*	0.0811	0.1932*
PB						1	0.5593**	-0.0146	-0.0159	-0.032	-0.1447	-0.0185	-0.0093	-0.0053
SB							1	0.1345	0.1303	-0.027	-0.0992	0.2506**	-0.0944	0.2064*
TNPP								1	0.9989**	0.1492	0.0604	0.7534**	0.0635	0.7988**
NEP									1	0.1525	0.0574	0.7581**	0.0638	0.8041**
NSP										1	-0.1847*	0.059	0.2001*	0.1327
100SW											1	0.0668	0.0328	0.0968
BY												1	-0.1388	0.9231**
HI													1	0.2163*
SYP														1

*Significant at 5% level, **Significant at 1% level. Abbreviation: DFI: Days to flower initiation, DF50%: Days to 50% flowering, DPI: Days to pod initiation, DM: Days to maturity, PH: Plant height, PB: Number of primary branches per plant, SB: Number of secondary branches per plant, TNP: Total number of pods per plant, NEP: Number of effective pods per plant, NSP: Number of seeds per pod, 100 SW : 100 seed weight, BY: Biological yield, HI: Harvest index, SYP: Seed yield per plant

Table-3 *Genotypic Path coefficient analysis for yield and its component traits in chickpea*

Character	DFI	DF 50%	DPI	DM	PH	PB	SB	TNP	NEP	NSP	100SW	BY	HI	Corrl.
DFI	0.0055	0.0047	0.0044	0.0007	0.0002	0.0018	0.0009	-0.001	-0.001	0.0009	0.0001	-0.0009	-0.0007	-0.196
DF 50%	0.0302	0.0349	0.0284	0.001	0.0108	0.0054	0.0048	-0.011	-0.0109	-0.0003	0.0047	-0.0062	-0.0069	-0.2418
DPI	-0.0341	-0.0345	-0.0424	0.0003	-0.0116	-0.0175	-0.0139	0.011	0.011	0.0021	-0.0051	0.007	0.0073	-0.2209
DM	-0.0071	-0.0016	0.0004	-0.0577	-0.0086	-0.0119	-0.0097	-0.028	-0.0282	-0.0058	0.0019	-0.0341	-0.0108	0.6215
PH	0.0002	0.0016	0.0014	0.0008	0.005	0.0002	0.0005	0.0001	0.0001	-0.0006	0.0009	0.0006	0.0019	0.1978
PB	0.0275	0.0131	0.0348	0.0174	0.0025	0.0846	0.0608	-0.0021	-0.002	-0.0129	-0.0169	-0.0032	0.0009	-0.0176
SB	-0.0083	-0.0067	-0.0161	-0.0082	-0.0053	-0.0352	-0.049	-0.0041	-0.0043	-0.0013	0.0064	-0.013	0.0062	0.0062
TNP	-0.4643	-0.7982	-0.6586	-1.2346	-0.0556	0.0631	0.2121	2.5412	2.5406	0.6282	0.1296	1.9839	0.207	0.8303
NEP	-0.4792	-0.8315	-0.6881	1.2955	0.0332	-0.0618	0.233	2.6511	2.6517	0.6649	0.1239	2.0782	0.208	0.8331
NSP	0.0041	-0.0002	-0.0013	0.0026	-0.0031	-0.004	0.0007	0.0064	0.0065	0.026	-0.0092	0.0021	0.0094	0.0094
100SW	-0.0002	0.0075	0.0066	-0.0018	0.0101	-0.0109	-0.0072	0.0028	0.0026	-0.0193	0.0548	0.0043	-0.0024	0.0912
BY	-0.1574	-0.1641	-0.1524	0.5458	0.1021	0.0347	0.245	0.7204	0.7232	0.0732	0.073	0.9228	-0.1197	0.9322
HI	-0.0416	-0.063	-0.0552	0.0599	0.118	0.0033	-0.0406	0.0259	0.025	0.1152	-0.0137	-0.0413	0.3185	0.2047

R Square = 0.9881 Residual Effect = 0.1089. Abbreviation: DFI: Days to flower initiation, DF50%: Days to 50% flowering, DPI: Days to pod initiation, DM: Days to maturity, PH: Plant height, PB: Number of primary branches per plant, SB: Number of secondary branches per plant, TNP: Total number of pods per plant, NEP: Number of effective pods per plant, NSP: Number of seeds per pod, 100 SW : 100 seed weight, BY: Biological yield, HI: Harvest index, SYP: Seed yield per plant

total number of pods per plant (90.2%). Moderate heritability recorded for number of secondary branches (63.4%) and number of primary branches (63.1%). Similar results were reported by [5, 7-10]. Genetic advance as percentage of mean was noted maximum in number of effective pods per plant (69.1%) followed by biological yield (68.5%) and total number of pods per pant (68.2%). These finding were in agreement with [8-19]. High heritability coupled with high genetic advance as percent of mean was registered for seed yield per plant followed by biological yield, number of effective pods per plant and total number of pods per plant. Traits with high heritability and genetic advance could be explained by additive gene action and have high response to selection. Importance should be given to these traits in breeding programme, Moderate heritability coupled with moderate genetic advance recorded for number of secondary branches followed by number of primary branches, whereas phenological traits *viz*., days to flower initiation, days to 50 % flowering, days to pod initiation, days to maturity exhibiting low genetic advance accompanied by high heritability indicate the non-additive gene action. Low heritability coupled with low genetic advance was assessed for the trait number of seeds per pod, indicating ineffectiveness of direct selection. Economic value/seed yield in crop plants is determined by many component traits which are contributing towards directly as well as indirectly. Trait association analysis, hence considered to be imperative in assessment of relation of component traits over

yield which in turns helps in selection of superior genotypes. The trait association analysis revealed seed yield per plant showed positive and significant correlation with biological yield (0.9231), number of effective pods per plant (0.8041), total number of pods per plant (0.7988), days to maturity (0.5995). Seed yield pre plant showed significant and negative association with phenological traits *viz*., days to 50% flowering (-0.2284), days to pod initiation (-0.2019) and days to flower initiation (-0.1819) [Table-3]. Biological yield per plant showed significant and positive correlation with number of effective pods per plant (0.7581), total number of pods per plant (0.7534), days to maturity (0.5680), number of secondary branches (0.2506) and plant height (0.1735). Number of effective pods per plant significant and positively correlated with total number of pods per plant (0.9989), days to maturity (0.4607), while significant and negatively correlated with days to 50% flowering (-0.2728) and days to pod initiation (-0.2479). Similarly, total number of pods per plant significant and positively correlated with days to maturity (0.4543), whereas significant and negatively correlated with days to 50% flowering (-0.2715) and days to pod initiation (-0.2465). Days to pod initiation was significant and positively correlated with number of primary branches (0.2714) and number of secondary branches (0.2550). Secondary branches were significant and positively correlated with number of primary branches (0.5593) and plant height (0.3240). In this study it is noted that 100 seed weight significant and negatively correlated with number of seed per pod (-0.1847). These findings supported by [3, 6, 17, 11-18]. The trait association analysis revealed that for increasing seed yield emphasis should be given on high biological yield, more number of total and effective pods per plant, while took more days for maturity but less days taken for phenological traits like flower initiation, 50% flowering and pod initiation. Hence, these traits might be very useful for considering of high yielding ideotype in chickpea.

Chickpea plant has complex mechanism for manifestation of seed yield per plant as this character is resultant of interactions between many of its components. Each yield component has a positive or negative contribution to overall expression on yield. Further, the influence of the yield components could be indirect or direct through other component characters. This experiment revealed that number of effective pod per plant (2.6517) and total number of pod per plant (2.5412) exhibited high direct positive effect on seed yield per plant followed by biological yield (0.9228) and harvest index (0.3185) at phenotypic levels. Similar findings were observed by [4, 12-20]. Number of effective pods per plant showed significant indirect effect on seed yield via total number of pods per plant (2.6511) followed by biological yield (2.0782) and days to maturity (1.2955). Total number of pod per plant showed positive significant indirect effect on seed yield via number of effective pod per plant (2.5406), biological yield (1.9839), number of seeds per pod (0.6282), number of secondary branches (0.2121) and 100 seed weight (0.1296), whereas days to maturity (-1.2346), days to 50% flowering (-0.7982), days to pod initiation (-0.6586) and days to flower initiation (-0.4643) showed negatively indirect effect on seed yield per plant. Biological yield showed positive significant indirect effect via number of effective pods per plant (0.7232) and total number of pods per plant (0.7204) while, days to 50% flowering (-0.1641), days to flower initiation (-0.1574) and days to pod initiation (-0.1524) showed negative indirect effect on seed yield per plant. The residual effects value observed very low (0.1089) indicated majority of traits considering in this study. [1, 5, 13-21].

Application of research: Research findings of present study suggested that selection of genotype having high biological yield, more secondary branches, a greater number of total and effective pods increase the yield potential of chickpea.

Research Category: Plant Breeding & Genetics

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***Research Guide or Chairperson of research: Dr Anita Babbar**
University: Jawaharlal Nehru Krishi Vishwa Vidyalaya, Adhartal, Jabalpur, 482004
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Study area / Sample Collection:

Cultivar / Variety name: Chickpea (*Cicer arietinum* L.)

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